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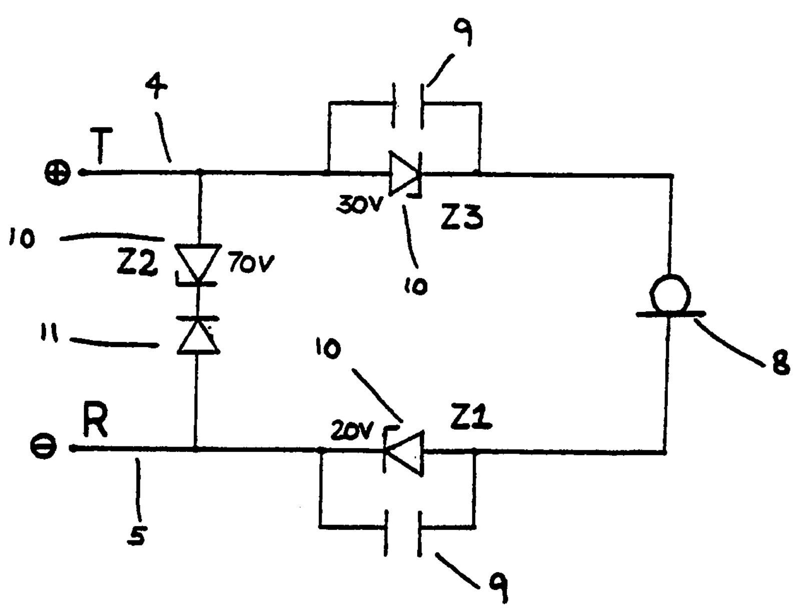

(57) Abstract

A device capable for use in investigating a fault in a telecommunications system comprising a first and a second part interconnected by a line, which device comprises: (a) a first circuit that can be connected in series with the line and comprising a first capacitor and a first component, such that an alternating current can pass along the line via the capacitor and a direct current can pass along the line via the first component in at least one direction with a threshold voltage; and (b) a second circuit that can be connected in parallel across the line and comprising a second component having a threshold voltage of greater than 48 volts and/or being able to pass direct current only in one direction.

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Telecommunications line test system

The present invention relates to a device capable of investigating a fault in a telecommunications system, particularly along a telecommunications line between an exchange and a subscriber.

It is clearly desirable that a fault be quickly located in order that it be quickly put right. In addition to determining location, by which we mean determining the general area of a fault, it is also desirable to determine the type of fault since this knowledge will help one to locate the fault more precisely. Thus it is desirable to be able to determine whether a fault is a short circuit, for example between tip and ring (to use USA terminology) telephone conductors, an open circuit or an earthed conductor.

The increasing use by subscribers of their own equipment, which is simply plugged into the telephone company's system by the subscriber, has made it desirable that one can determine on which side of the plug a fault lies. The reason is that a fault on the exchange side of the plug and socket is the responsibility of the telephone company, and a fault the other side may be the responsibility of the subscriber. A fault on the subscriber's side may be due to faulty subscriber equipment or to faulty connection, and in either case location of the fault can save time and the telephone company's expense by avoiding unnecessary line testing.

Thus, devices have been proposed for incorporation at the boundary between the telephone company's and the subscriber's responsibility. In particular such devices may be part of the socket into which a subscriber plugs his telephone or other equipment.

Japanese patent specifiation A 58-63260 for example describes a fault detector for communications equipment which enables precise determination of the nature of a fault and the place of its occurence to be made from the telephone exchange, and so makes rapid repair possible.

This prior art fault detector is said to comprise a control part and a detector part, the control part comprising diodes inserted in series between the pair of conductors of a telephone line and the subscriber, and a varistor connected across the two conductors. The varistor must have a threshold value higher than the threshold values of the diodes. The detector part comprises a variable voltage power unit, a current detector which can detect the current flowing in the conductors as a function of the variable voltage applied, and a voltage detector.

We have found however that the circuitry of the control part of the prior art fault detector has some significant disadvantages. Firstly, the voltage required to be applied to the telephone line has to be higher than is preferred for safety reasons (more than 100 volts is required), a sharp current-voltage curve cannot be relied on, and the detector's performance is likely to fluctuate with temperature.

An alternative device has now been designed that can overcome these problems.

Thus, the present invention provides a device capable for use in investigating a fault in a telecommunications system comprising a first and a second part interconnected by a line, which device comprises:

(a) a first circuit that can be connected in series with the line and comprising a first capacitor and a first component, such that an alternating current can pass along the line via the capacitor and a direct current can pass

along the line via the first component in at least one direction with a threshold voltage; and

(b) a second circuit that can be connected in parallel across the line and comprising a second component having a threshold voltage of greater than 48 volts and/or being able to pass direct current only in one direction.

The invention also provides a device capable for use in investigating a fault in a telecommunications system comprising a first and a second part interconnected by a line, which device comprises:

(a) a first circuit that can be connected in series with the line and comprising a first component, such that an alternating current can pass along the line and a direct current can pass along the line via the first component in at least one direction with a threshold voltage; and

(b) a second circuit that can be connected in parallel across the line and comprising a second component comprising at least one zener diode and having a threshold voltage of greater than 48 volts and/or being able to pass direct current only in one direction.

The invention further provides a device capable for use in investigating a fault in a telecommunications system comprising a first and a second part interconnected by a line, which device comprises:

(a) a first circuit that can be connected in series with the line and comprising a first component comprising a zener diode, such that an alternating current can pass along the line via the capacitor and a direct current can pass along the line via the first component in at least one direction with a threshold voltage; and

(b) a second circuit that can be connected in parallel across the line and comprising a second component having a threshold voltage of greater than 48 volts and/or being able to pass direct current only in one direction.

A telecommunications line generally comprises a pair of conductors from the first part (such as an exchange) to the second part (such as subscriber equipment), the single pair carrying information, such as speech, in both directions. In this case the second component referred to above is connected across those two conductors. A line may however comprise four conductors, in two pairs, each pair carrying information in a single direction. In that case a device of the invention may be provided for each pair.

We prefer that the first circuit comprises a capacitor and a first component in series with each of the conductors of a pair. In this case, we will refer to a first capacitor and a first component in series with one conductor and a second capacitor and third component in series with the second conductor. This terminology is used because the precise characteristics (such us capacitance and threshold voltage) of the two capacitors and of the first and third components may differ, although they will function as defined above.

We prefer that the first, second and third components each comprises a zener diode. In any case, each of said components may comprise two or more physically separate electrical or electronic components in electrical connection.

The second component preferably has a threshold voltage of greater than 48 volts, more preferably greater than 55 volts, especially from 60-75 volts. Where the threshold voltage is less than 48 volts, the usual operating voltage of a line, some means should be provided to ensure that the subscriber apparatus is not shorted out at the normal operating voltage. This may be achieved by employing means, such as a diode, for preventing current passage through the second component in a direction opposite to that at which it

exhibits its threshold voltage. Thus, the system is normally operated using a source of direct current such that the second circuit is non-conductive. The polarity is reversed for at least part of the test, under which conditions the threshold voltage may be exhibited. The threshold voltage of the second component is preferably greater than that of the first circuit (generally the sum of that of the first and third components) unless said means for preventing the opposite passage of current is employed.

The reason is that otherwise the second circuit will not come into play. Where the threshold voltage of the second component is greater than 48 volts (the normal as opposed to the test voltage) this problem need not arise and the device will be operable with either polarity of normal operating voltages between the conductors of the line. This is desirable because in many countries the polarity that is established on making a telephone call is random.

The general principle of operation of the device can now be seen. What is required is a unique voltage-current curve corresponding to each of the fault conditions in the line to be tested. A voltage is applied, either between the two conductors of the line or between one of them and earth, depending on the test; and the current flowing in the line is measured. This is done for selected different voltages or continuously over a range of voltages. The current voltage curves will differ depending on where a fault lies, because the different faults will cause current to follow different paths. For example the current may flow through the first circuit, through the second circuit, through part of one or both circuits, or not at all. The voltage is preferably applied, and the current and voltage measured at the telephone exchange. Thus the device of the invention may be used for remote investigation.

The first, second and third components will give rise to characteristic sudden increases in current at their threshold voltages, V1,V2 and V3 respectively and at those voltages preferably become substantially conducting. For example the total circuit may then have a resistance of less than 2000, preferably less than 1100 ohms. A threshold voltage is therefore a predetermined voltage or voltage range at or over which a component or a circuit exhibits a sharp change in resistivity. If the current-voltage curve shows a sudden increase in current at about V1, then one may conclude that the current is flowing through the first component. Similarly, if an increase occurs at V2 + V3, then current is flowing through the second and third components, but not through the first (at least not in the direction in which the threshold voltage is exhibited). We prefer that the threshold voltage of the second circuit is greater than, particularly by at lease 15 volts, especially by at least 30 volts, that of the first circuit.

As an example, normal operation of the telecommunications system may involve current flowing through the first circuit. The capacitors are preferably provided in order that an alternating signal may pass substantially unrestricted to allow a ringing tone (generally an AC signal superimposed on a DC bias of usually 48 volts) and that a DC audio signal or other signal may to be passed between the first part and the second part. If the threshold voltage of the first and third (where provided) components together is much less than the operating voltage of the system, the direct current for normal operation may be applied at either polarity. If the total of the threshold voltages is higher, then normal operation will require connection such that current flows in the opposite direction to that at which the threshold voltages are exhibited. In that case the polarity has to be reversed for at least part of the test.

It may be possible that the first and third components exhibit their threshold voltages at opposite polarities, ie they are connected in series back-to-back. In this case the normal operating voltage will need to be higher than only one of the threshold voltages.

We prefer that the device be able to distinguish between two or more of the following conditions:

1. A short circuit within the first part of the system (for example the telephone company's property)
2. An open circuit within the first part
3. A short within the second part (for example the subscriber's property)
4. An open circuit within the second part
5. An earthed conductor within the second part
6. An earthed ring conductor within the first part.
7. An earthed tip conductor within the first part.

(The terms "ring" and"tip" are standard terms used to distinguish between the two conductors of a line. In a non-symmetrical system, for example as used in the USA, the tip is generally at 0 volts and the ring at -48 volts. In Europe and elsewhere, the system is symmetrical and the polarity applied is random.)

The device should also be substantially transparent, preferably exhibiting a voltage drop of less than 15 preferably less than 10 volts, during normal direct current operation of the line. It should also be substantially transparent to alternating current in order that a ringing tone may be transmitted.

The invention is further illustrated with reference to the accompanying drawings, in which:

Figure 1 shows a telecommunications system;

Figure 2 shows a prior art device;

Figures 3 and 4 show devices of the invention;

Figure 5-7 show various faults in a telecommunications system;

Figures 8 and 9 show current-voltage relationships obtained from devices of the invention; and

Figures 10 and 11 show a preferred device and related current-voltage relationship.

A telecommunications system is represented schematically in Figure 1. An exchange 1 is connected to a subscriber 2 by a line 3 comprising tip and ring conductors 4 and 5 respectively. The dotted line shows a possible division between the telephone company's responsibility and a subscriber's responsibility. A device of the invention may be placed in the line 3 at the position of the dotted line in order that one can determine whether a fault is the responsibility of the telephone company or the subscriber. Preferably the device of the invention is incorporated in a connection block which also comprises a housing and a telephone socket. The block may be mounted on a wall of a building. The invention may be used at other positions in a telecommunications system and "1" may be regarded as a first part of a system (as referred to above) and "2" as a second part.

A prior art device for locating a fault is shown in Figure 2. This device comprises an electrical circuit of two pairs of diodes 6, the pairs being in series with the tip 4 and ring 5 conductors respectively. A varistor 7 is connected across the tip and ring conductors. The diodes of each pair are connected in opposite fashion. We have found that this circuit is somewhat susceptible to temperature variation and the current-voltage relationships for the

various different faults to be investigated are not sufficiently distinct. We have also found that the circuit causes some attenuation to a signal during normal use of the line, and requires unacceptably high test voltages.

The present invention adopts a different approach, as is illustrated in Figures 3-9.

In Figure 3 capacitors 9 and zener diodes 10 in parallel are together connected in series with respective conductors of the line. For some investigations a capacitor/zener diode pair may be required in only one of the lines. A zener diode 10 and ordinary diode 11 (ie a diode that is substantially non-conductive in one direction over the voltage range at which it is to be used, preferably up to 80 volts) are connected in opposite fashion between the tip conductor 4 and ring conductor 5. In a modification of this design, component 11 is also a zener diode.

The first and second circuits can now be seen. The first circuit comprises the zener diode Z1 (the first component referred to above) the telephone 8 (or rather a connections therefor since the telephone is not part of the circuit per se) the zener diode Z3, and the two capacitors 9. The second circuit comprises the zener diode Z2 (the second component referred to above) and the ordinary diode 11.

For normal operation of the telephone a voltage of generally 48 volts is applied between the tip and ring conductors. (Tip and ring is terminology used in the USA where the line is non-symetric, but it will be used here also to refer to symetric lines although designation of each line will be arbitiary.) The telephone company will first have sent a ringing tone (where the telephone 8 is receiving a call) by means of an alternating current, and this can flow

in the first circuit through the capacitors 9 with little or no attenuation. The capacitors preferably are substantially transparent to audio frequencies, and preferably have a capacitance of at least 5 microfarads, especially at least 10 microfarads. The second circuit will not be in use because the threshold value of Z2 is 70 volts, ie greater than the 48 volts operating voltage, and because of the diode 11.

In the embodiment illustrated, the zener diodes Z1 and Z3 have threshold voltages of 20 and 30 volts respectively. Since the voltage applied for normal use (48V) is less than the total voltage drop for reverse operation of these diodes (ie the total threshold voltage of the circuit) the circuit will only work at signal frequencies at which the capacitors are substantially transparent. Thus, the capacitors may be chosen to allow passage of normal audio frequencies. Preferably the capacitors have a capacitance of at least 10 microfarads. Where polarity is predetermined, preferred values for Z1 and Z3 are 5-40 especially 15-25 volts for Z1, and 15-65 especially 25-35 volts for Z2. The total threshold voltage of the first circuit is preferably less than 70 volts, especially 40-60 volts.

A test is made by reversing the polarity so that the tip conductor 4 is negative with respect to the ring conductor 5. The voltage is then increased from 0, up to a value somewhat above the greater of the threshold voltages of the first and second circuits, in this case 70 volts. The current flowing is measured as a function of voltage. The current-voltage relationship may be determined continuously over, say, the range 0-75 volts, or it may be sampled at values for example slightly below and above each of the threshold voltages, ie 18,22,28,32,48,52,68 and 72 volts. What is desired is a different current-voltage relationship for each fault. The path the current takes, and

therefore the zener diode or diodes whose threshold value or values must be reached, will depend on the location of the fault. Examples are given for various faults in Figures 8 and 9.

The device shown in Figure 4 is a modification of that of Figure 3, designed for normal telephone operation under either polarity. Again, component 11 may be a zener diode thus making the device completely symetric.

Since the telephone 8 must work under either polarity, zener diodes Z1 and Z3 must not provide an excessive voltage drop for either direction of current flow in this case we prefer that each has a threshold voltage of 15 volts or less, preferably less than 10 volts, more preferably less than 7 volts, and that their combined threshold voltage is less than 20 volts. It is also desirable that their threshold voltages be different (to be explained below) and we prefer values of 1.5-4, especially 2.5-3.5 volts, and 4-7 especially 4.5 to 5.5 volts.

Again, since current may flow in either direction during normal telephone operation, the threshold voltage of Z2 must be greater than the normal operating voltage, usually 48 volts. If this were not so, the telephone would be short circuited by the second circuit during normal operation under one of the two polarities.

In Figure 4 a telephone or other equipment 8 is represented by its resistance, and the resistances of the lines are shown as 12. A reverse polarity switch 13 connects the line to a source of variable voltage power 14 for testing. During testing the applied voltage is measured at X and the current flowing is measured at Y, for example by measuring the voltage drop across a known resistor. The outputs from voltmeter X and ammeter Y may be plotted as the X and Y axes of a graph, as shown in Figures 8 and 9.

Figure 4 therefore shows a control unit C, a line (and exchange etc) L a device of the invention D and a subscriber's telephone S. The device D will determine whether a fault falls in region L or region S and whether that fault is a short circuit, an open circuit or an earth.

Figure 5 shows an open circuit 15 at the subscriber. On application of a voltage for testing, any current must flow through the second circuit, and this will be indicated by a current-voltage above showing, if line 5 is made positive, the threshold voltage of the second component, ie zener diode Z2. If line 4 is made positive, no current will flow due to diode 11. An open circuit on the exchange side, ie region L of Figure 4, would prevent current flowing completely.

Figure 6 shows a short 16 on the exchange side. The current-voltage curve will now show no threshold voltage since the current path involves neither the first nor second circuit. The slope of the curve will be substantially constant, and will give the resistance of the line (together with that of the short itself). The same result will be obtained for either polarity.

In Figure 7 the fault is an earth connection 17 at the subscriber. This is revealed by applying the test voltage between one of the conductors 4 and 5, and earth. In general it will be necessary only to apply the voltage between one of the conductors and earth, but the test may be continued using the other conductor. The current will now flow through part of the first curcuit, ie through the zener diode Z1, but not through the zoner diode Z3. The current-voltage curve will therefore exhibit the threshold voltage of Z1 when conductor 5 is positive and no threshold voltage when conductor 5 is negative with respect to earth. If the

voltage were applied between the other conductor and earth, the theshold voltage of Z3 would be exhibited. It will not always be necessary to extend the test over both polarities since this will depend on the amount of information required, and on the threshold values of the circuits. An earth fault on the exchange side will mean no current will flow through the first or second circuits, and the current-voltage curve will not show a threshold voltage. This fault is however distinguishable from the fault of Figure 6 because different tests are required to produce the similar current-voltage curves. Also, the curves will be slightly different since the resistances of the two resulting current paths are likely to be different.

Figure 8 shows the current-voltage curves produced from the device of Figure 3 under the following faults:

Figure 8a short at exchange or line
Figure 8b short at subscriber
Figure 8c earth at exchange or tip conductor of line
Figure 8d earth at exchange or ring conductor of line
Figure 8e earth at subscriber
Figure 8f open circuit at exchange or line
Figure 8g open circuit at subscriber.

The tests were carried out as explained in relation to Figures 5-7. In each case the X-coordinate of the graph is the voltage measured as X in Figures 5-7 with positive values refering to a positive ring conductor, and the Y-coordinate is the current measured as at Y in Figures 5-7.

The graph of Figure 8b is similar to what would be obtained if the test were carried out in the absence of the fault. It will not, however, generally be necessary identify a lack of a fault by means of a test. The graph may be less steep in the absence of a subscriber fault due to the added resistance of the telephone.

The threshold values of Z1 + Z3 can be seen in Figures 8b and 8c, of Z1 in Figure 8e and of Z2 in Figure 8g.

Figures 9a-9g correspond to Figures 8a-8g, but apply to a modified circuit of Figure 3 where the threshold voltages of Z1,Z2 and Z3 are 3,4 and 5 volts respectively, and where Z3 is reversed. This shows that Z2 need not be higher than both Z1 and Z3.

A particularly preferred device is shown in Figure 10, and the various current-voltage relationships it generates are shown in Figues 11A-11E. This device may be entirely symmetric and is therefore ideal for European telephone circuits where the imposed polarity is random. The circuit of Figure 10 includes four zener diodes 10, namely Z1,Z2,Z3 and Z4. A short circuit during normal telephone operation and during the ringing tone is avoided by the threshold voltages for Z2 and Z4 being greater than the operating voltage, for example greater than 48 volts which is the DC voltage on which an AC ringing signal is often impressed. The threshold voltages of Z2 and Z4 may conveniently be 100-130 volts. The zener diodes Z1 and Z3 may if desired have low threshold voltages, for example in the range of a few volts, for example less than 10 volts, preferably less than 5 volts, especially less than 3 volts. This avoids an unacceptable DC voltage drip across one of them (across which will depend on the operating plarity) of the DC bias voltage during normal operation. The zener diodes Z1 and Z3 may have the same threshold voltage, during but they may have different voltage in which case earthing at the subscriber of respective lines will be distinguisliable.

The capacitors 9 preferably each have a capacitance of greater than 5, especially greater than 10 microfarads. The pairs of diodes Z1, Z3 and/or Z2,Z4 may be reversed where

the device is to be used on lines of fixed polarily (as is the case in the USA) one only of the diodes Z1 and Z2 may be reversed.

Because the circuit is symetrical, the current/voltage graphs will be in principle symmetrical. Hence in Figures 11A-11E only the top right quadvants of the graphs have been completed, the lower left hand quadiants will be similar, although the precise threshold voltages may be different.

Figure 11A shows the normal situation when the telephone is not being used. The threshold voltage of Z2 or Z4 (which may be different but are preferably substantially equal) will be apparent.

In Figure 11B an open circuit at the exchange or line results in no current flow.

Earth leakages of two different resistance at the exchange or line is shown in Figure 11C.

The threshold voltage of identical diodes Z1 or Z3 is shown in Figure 11D wnere there is earth leakage on the subsscribers side. Again two different leakage resistances are shown. This system cannot distinguish between a leakage from line 4 and from line 5.

In Figure 11E zener diodes Z1 and Z3 have different threshold voltages allowing the position of a subscriber earth leakage to be determined. The graph shows two leakage resistances at line 4 (left hand pair of curves) and at line 5 (right hand pair of curves).

For the avoidance of doubt it is here stated that the invention provides a device for investigating a fault in a telecommunications system where a useful current voltage

relationship can be generated, particularly a threshold voltage which is distinguishable from noise often to be found in telecommunications lines. The device may comprise any one or more of the various components interconnected in any of the various ways described herein. For example any one or more of the zener diodes, capacitors, switches, power sources, and measuring devices may be selected.

CLAIMS

1. A device capable for use in investigating a fault in a telecommunications system comprising a first and a second part interconnected by a line, which device comprises:

(a) a first circuit that can be connected in series with the line and comprising a first capacitor and a first component, such that an alternating current can pass along the line via the capacitor and a direct current can pass along the line via the first component in at least one direction with a threshold voltage; and

(b) a second circuit that can be connected in parallel across the line and comprising a second component having a threshold voltage of greater than 48 volts and/or being able to pass direct current only in one direction.

2. A device according to claim 1, which additionally comprises a second capacitor and a third component exhibiting a threshold voltage (as herein defined), the first capacitor and first component being connected in parallel with each other and being each connectable in series with a first conductor of the line; and the second capacitor and third component being connected in parallel with each other and being each connectable with a second conductor of the line.

3. A device according to claim 1 or 2, in which the first capacitor, and where present the second capacitor, has a capacitance of at least 10 microfarads.

4. A device according to any preceding claim, in which the first circuit has a threshold voltage of less than 20 volts and the second component has a threshold voltage greater than 48 volts and the second circuit can pass direct current in only one direction.

5. A device according to claim 4, in which the threshold value of the second component is from 55-90 volts.

6. A device according to claim 5, in which the threshold value of the second component is from 65-75 volts.

7. A device according to any of claims 4,5 and 6 in which the threshold voltage of the first component is less than 7 volts.

8. A device according to claim 7, in which the threshold voltage of the first component is from 4-7 volts and that of the second component where present is from 1.5-4 volts.

9. A device according to any of claims 1-3, in which the first circuit has a threshold voltage of 20-70 volts.

10. A device according to any preceding claim, in which the threshold voltage of the second circuit is greater than that of the first circuit.

11. A device according to claim 10, in which the threshold value of the second circuit is at least 15 volts greater than that of the first circuit.

12. A device according to any preceding claim in which the second circuit has a diode by means of which it is able to pass current in only one direction.

13. A device according to any preceding claims in which one or more of the first, second and where provided third components is a zener diode.

14. A device capable for use in investigating a fault in a telecommunications system comprising a first and a second part interconnected by a line, which device comprises:

(a) a first circuit that can be connected in series

with the line and comprising a first component, such that an alternating current can pass along the line and a direct current can pass along the line via the first component in at least one direction with a threshold voltage; and

(b) a second circuit that can be connected in parallel across the line and comprising a second component comprising at least one zener diode and having a threshold voltage of greater than 48 volts and/or being able to pass direct current only in one direction.

15. A device according to claim 14 in which the second component comprisess two zener diodes back-to-back.

16. A device capable for use in investigating a fault in a telecommunications system comprising a first and a second part interconnected by a line, which device comprises:

(a) a first circuit that can be connected in series with the line and comprising a first component, comprising a zener diode, such that an alternating current can pass along the line via the capacitor and a direct current can pass along the line via the first component in at least one direction with a threshold voltage; and

(b) a second circuit that can be connected in parallel across the line and comprising a second component having a threshold voltage of greater than 48 volts and/or being able to pass direct current only in one direction.

17. A connection block for a telephone, comprising a housing, a telephone socket and a device according to any preceding claim.

18. A method of remote investigation of a telecommunications system having a device according to any of claims 1-16 connected between (a) a first part and a line thereof and (b) a second part thereof, which comprises applying selected voltages to the line from the first part and measuring the current flowing at the first part.

FIG.1

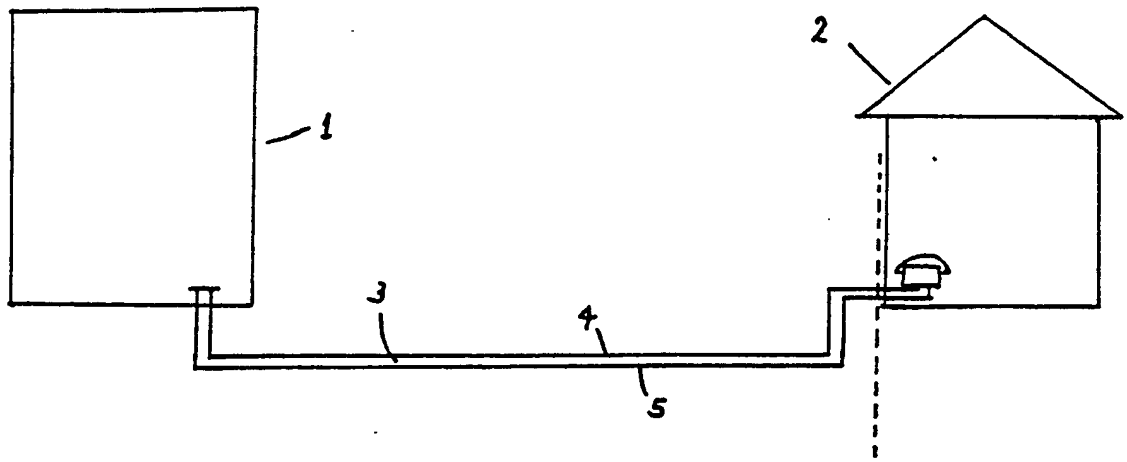
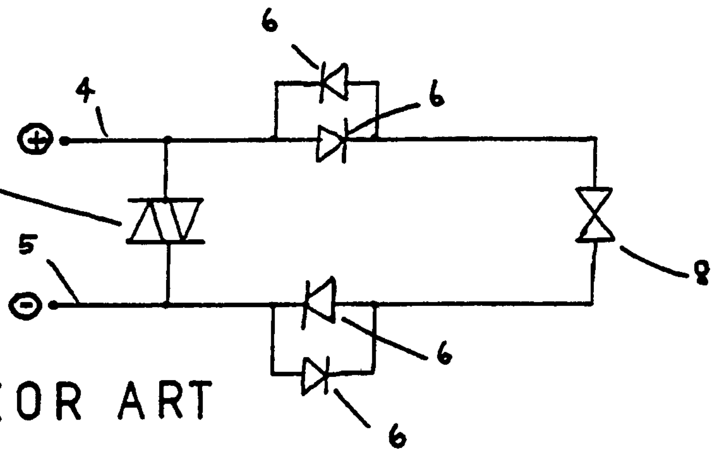


FIG.2



PRIOR ART

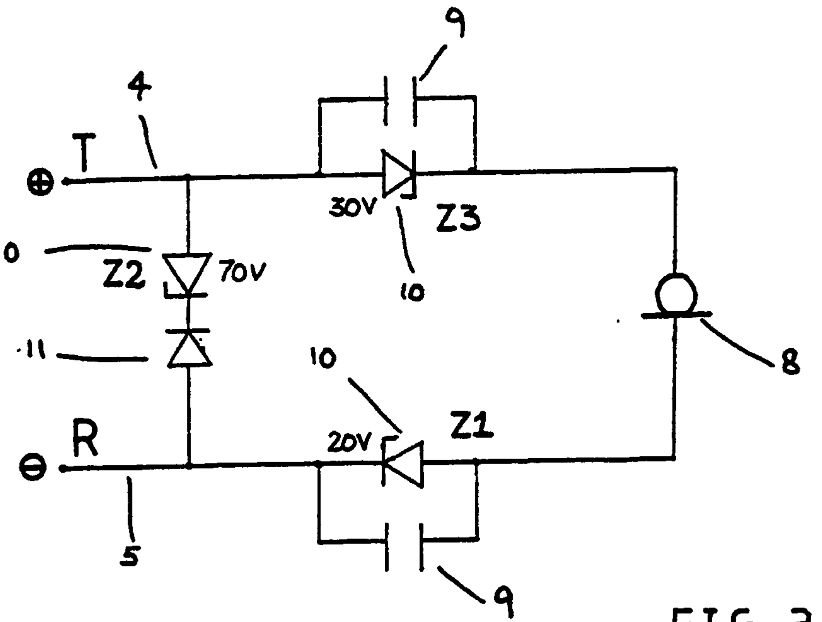
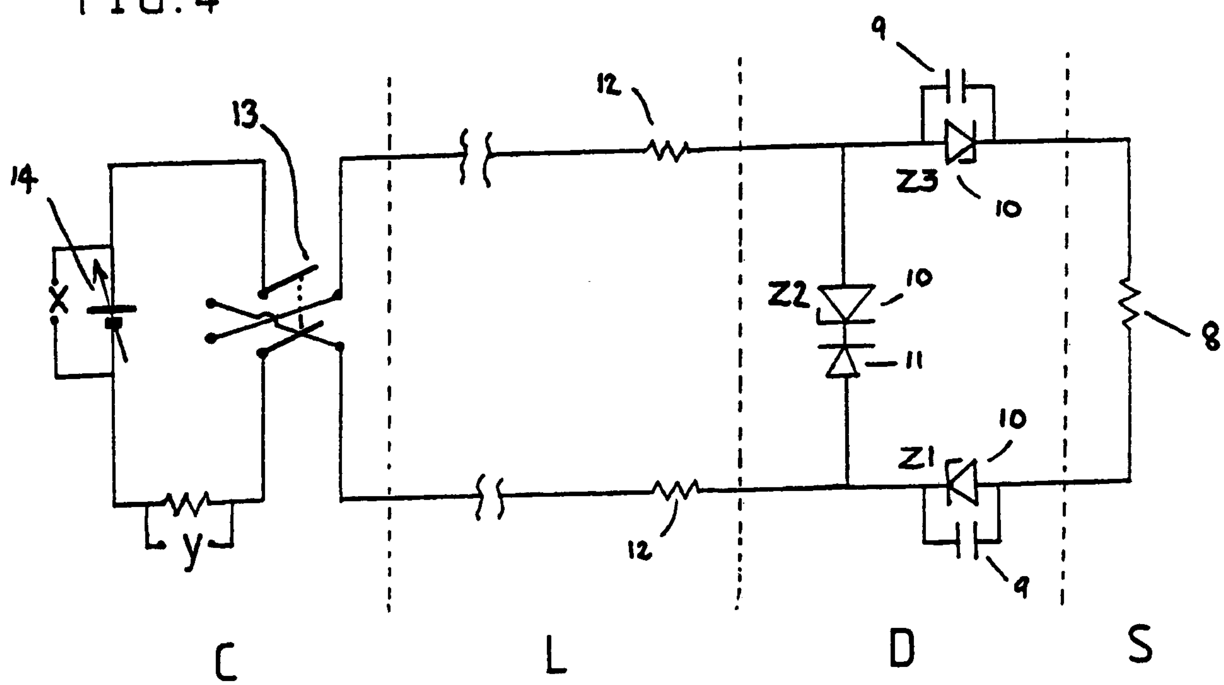

9
4
T
30V
Z3
10
Z2
70V
10
11
10
8
R
20V
Z1
5
9

FIG. 3

FIG. 4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D
S

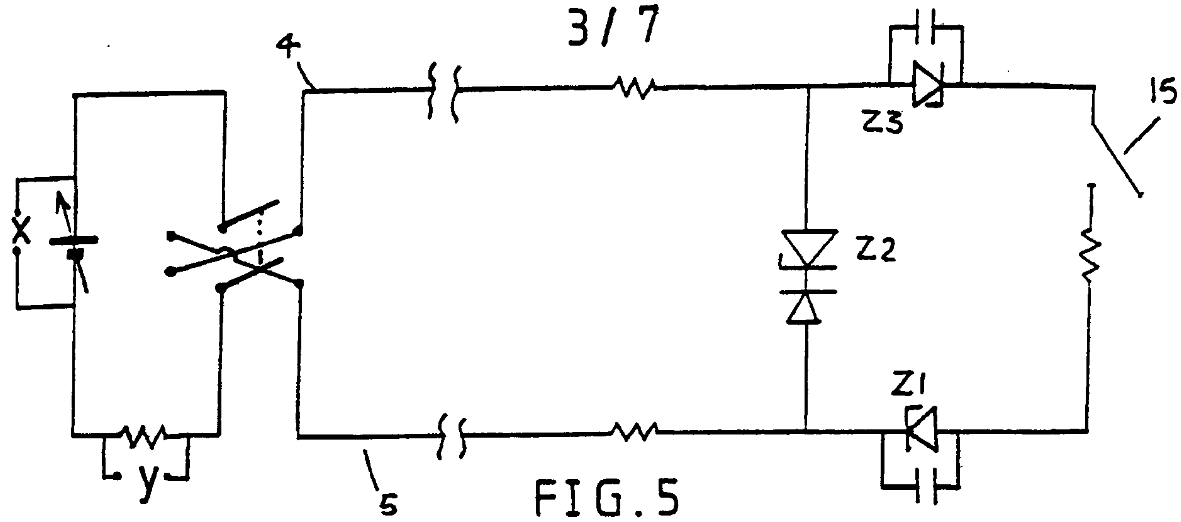

FIG.5

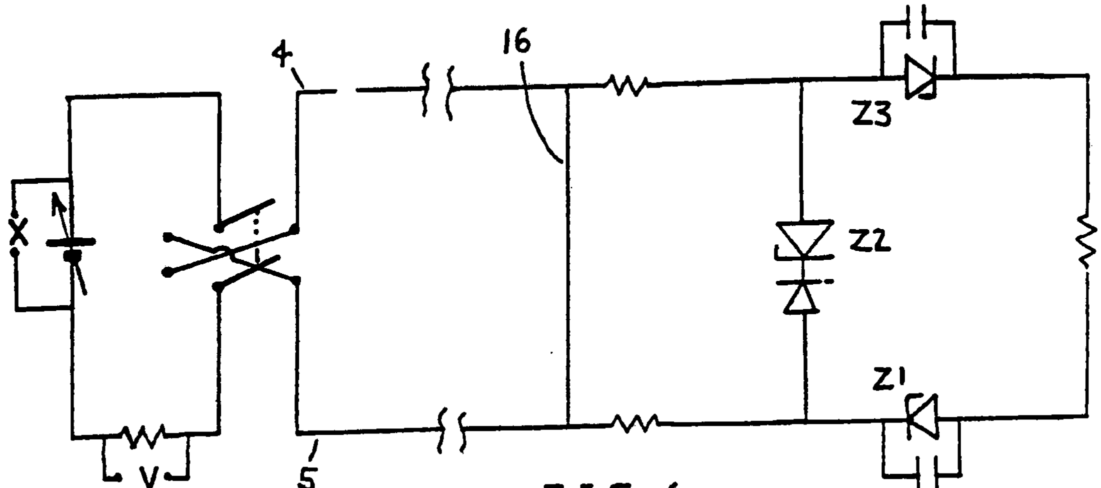

FIG.6

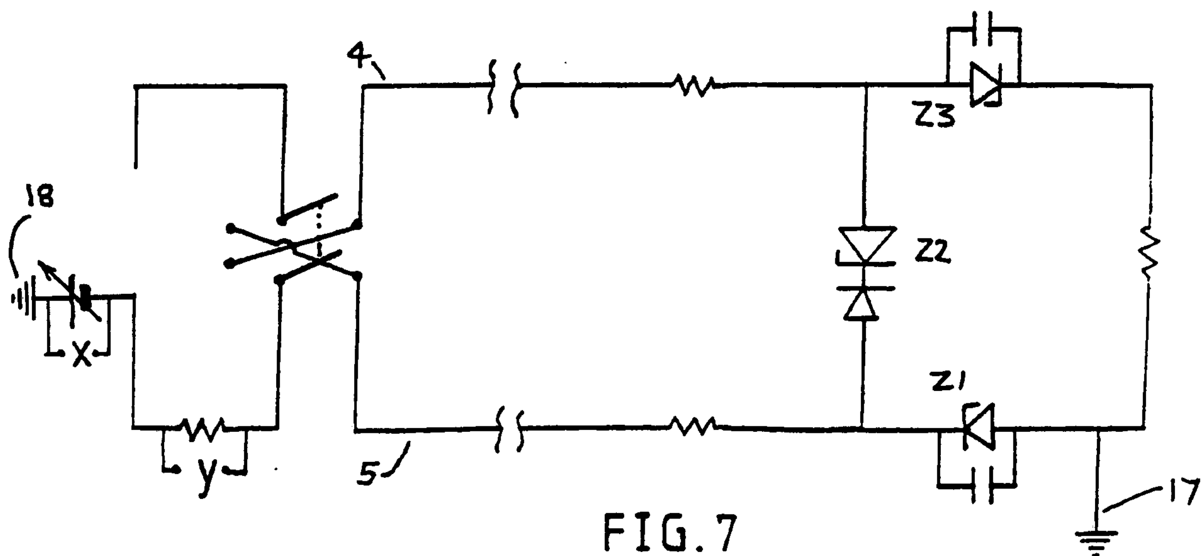

FIG.7

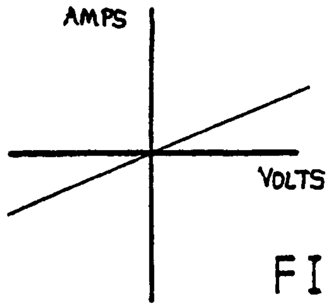

FIG.8A

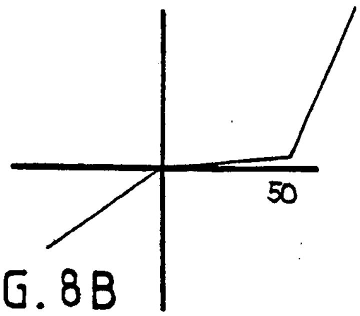

FIG.8B

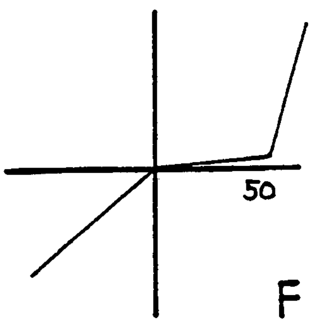

FIG.8C

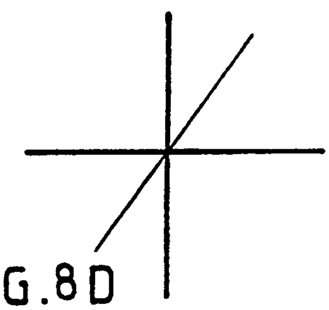

FIG.8D

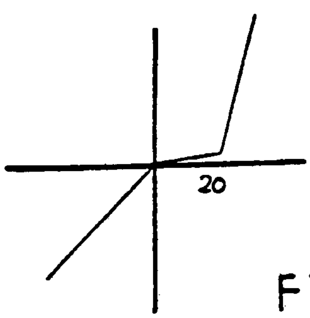

FIG.8E

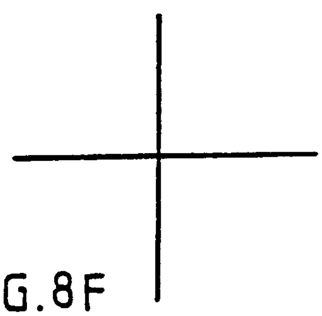

FIG.8F

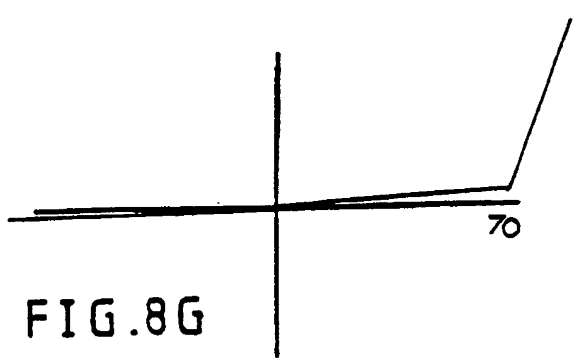

FIG.8G

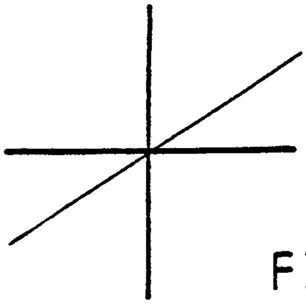

FIG. 9A

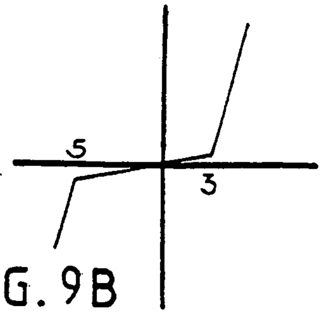

FIG. 9B

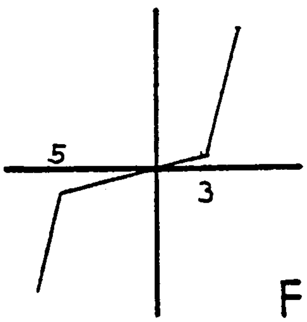

FIG. 9C

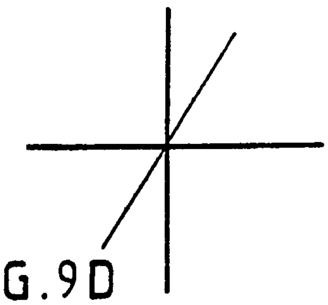

FIG. 9D

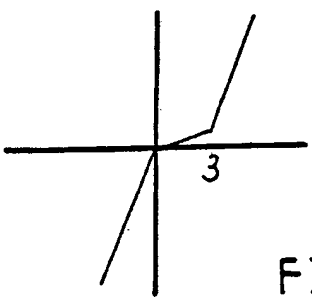

FIG. 9E

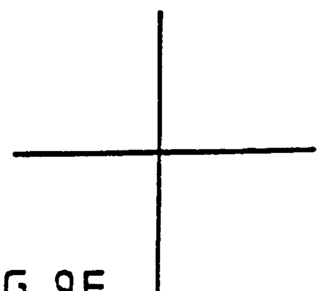

FIG. 9F

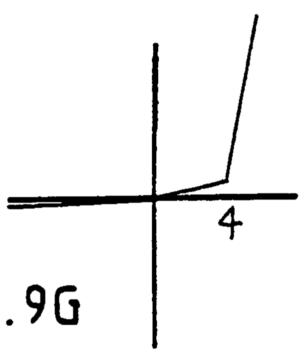

FIG. 9G

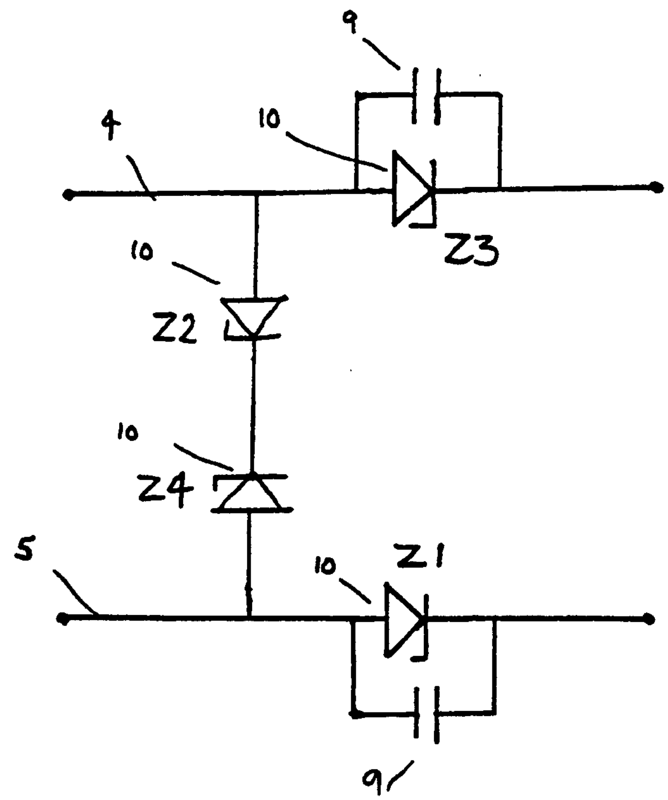

FIG.10

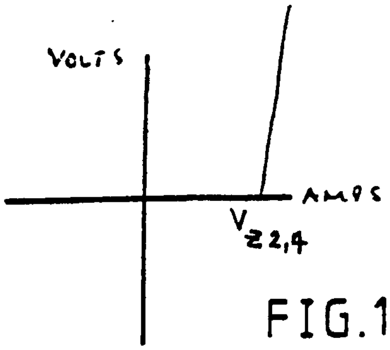

FIG.11A

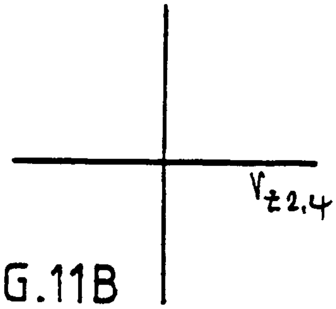

FIG.11B

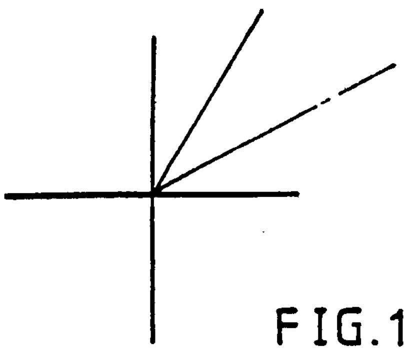

FIG.11C

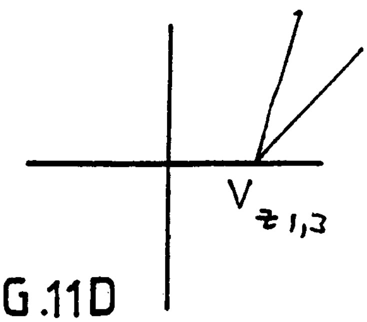

FIG.11D

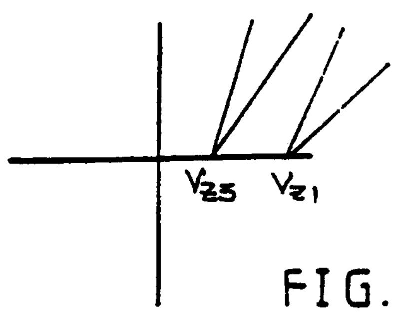

FIG. E

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/00129

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: H 04 M 3/30

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	H 04 M

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X Y	US, A, 4415779 (H.C. BOWMAN) 15 November 1983, see column 3, line 58 - column 9, line 5; figures 1-3	1-14,16-18 15
	--	
Y	EP, A1, 0082800 (FRITZ KUKE KG) 29 June 1983, see page 1, line 1 - page 3, line 32; figure 1	15
	--	
	--------	

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
15th April 1991	21. 06. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	Mme. M. van der Drift

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/GB 91/00129

SA 44268

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 23/03/91
The European Patent office is in no way liable for theseparticulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4415779	15/11/83	NONE	
EP-A1- 0082800	29/06/83	DE-A-C- 3148740 DE-A- 3304003	09/06/83 16/08/84

For more details about this annex : see Official Journal of the European patent Office, No. 12/82

EPO FORM P0479